IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:)	
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LILIAN LABELLE)	
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Application No.: N.Y.A.)	
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Filed: Concurrently Herewith)	
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For: METHODS AND DEVICES FOR)	
INDEXING AND SEARCHING :	
FOR DIGITAL IMAGES TAKING)	
INTO ACCOUNT THE SPATIAL :	
DISTRIBUTION OF THE CONTENT)	
OF THE IMAGES :	April 17, 2001

Commissioner for Patents
Washington, D.C.   20231

PRELIMINARY AMENDMENT

Sir:

Prior to examination, and contemporaneous with the

filing of the above-identified application, filed herewith,

please amend the present application as follows:

IN THE CLAIMS:

Please cancel Claim 19 without prejudice or

disclaimer of subject matter.

Please amend Claims 1-18 and 20-24 to read as follows (a version of these claims, marked to show the changes, is appended):

1.   (Amended) A method of indexing a digital image, comprising the following steps:

generating a first information item (H(Im)) characteristic of the visual content of the said image (Im);

generating a second information item characteristic of the spatial distribution of the visual content of the image in its image plane;

associating, with the image, an index composed of the first information item and the second information item

.

2.   (Amended) A digital image indexing method according to Claim 1, wherein said step of generating the first information item comprises the following substeps:

dividing the image plane of the image according to a partitioning comprising a predefined number N of blocks;

extracting, from each of the blocks, a data item of a first type representing at least one characteristic of the visual content of the block under consideration;

generating the first information item as being a vector having N components, each of which is one of the data items of the first type.

3.   (Amended) A digital image indexing method according to Claim 2, wherein said step of generating the second information item comprises the following substeps:

calculating, for each of the blocks, a data item of a second type indicative of a degree of significance of the visual content of the block under consideration with respect to the overall content of the image;

generating the second information item as being a vector having N components, each of which is one of the data items of the second type.

4.   (Amended) An image indexing method according to Claim 3, wherein, for each of the blocks, the data item of a second type, indicative of a degree of significance of the visual content of the block under consideration with respect

to the overall content of the image, is obtained by applying the following formula:

$$w_i^{\text{Im}} = \frac{\left\| h_i^{\text{Im}} \right\|}{\sum\limits_{i=1}^{N} \left\| h_i^{\text{Im}} \right\|}$$

according to which the data item of the second type (w_i^{Im}) is obtained by calculating the ratio between the Euclidean norm of the data item of the first type associated with the block under consideration and the sum of the Euclidean norms of the data items of the first type associated with all the blocks of the image.

5.   (Amended) An image indexing method according to any one of Claims 2 to 4, wherein the image plane of the image is divided according to a rectangular grid.

6.   (Amended) An image indexing method according to Claim 5, wherein the predefined number N of blocks is equal to sixteen.

7.   (Amended) A digital image indexing method according to Claim 2, wherein:

the image plane of the image is divided according to a quadtree decomposition process by means of which, at each phase of the decomposition, a block under consideration, referred to as the "parent block", is decomposed into four blocks, referred to as "child blocks", equal in size to a quarter the size of the parent block, and whose combination gives the parent block, the decomposition beginning with the overall image plane of the image and finishing when the predefined number N of blocks is reached;

at each phase of the decomposition, there is calculated, for each of the child blocks, a data item of a second type, indicative of a degree of significance of the visual content of the child block under consideration with respect to the overall visual content of the parent block; and

the second information item is composed of the set of the data items of the second type stored according to a quadtree structure, each node of which is constituted by one of the data items of the second type.

8.   (Amended) An image indexing method according to Claim 7, wherein:

at each phase of the quadtree decomposition of
the image, there is extracted, from the parent block under
consideration, a data item of the first type representing at
least one characteristic of its visual content and, for each
child block obtained by decomposition of the parent block ,
there is extracted a data item of the first type representing
at least one characteristic of the visual content of the
child block under consideration;

the data item of the second type indicative of
a degree of significance of the visual content of a child
block under consideration with respect to the overall visual
content of the corresponding parent block is obtained by
applying the following formula:

$$w_i^p = \frac{\left\| h_f^p \right\|}{\left\| h_p \right\|}$$

according to which the data item of the second type
calculated for a child block under consideration is obtained
by calculating the ratio between the Euclidean norm of the
data item of the first type extracted for the said child
block under consideration and the Euclidean norm of the data

item of the first type extracted from the corresponding parent block.

9. (Amended) An image indexing method according to any one of Claims 2 to 4, wherein each of the data items of the first type, representing at least one characteristic of the visual content of a block under consideration of the image, represents the distribution of colours in the block.

10. (Amended) A method of searching for images, from an example image, in a database in which digital images are stored, wherein the example image and each of the images stored in the database are indexed according to an image indexing method in accordance with Claim 1.

11. (Amended) An image search method according to Claim 10, comprising the following steps:

calculating a first similarity between the example image and each of the images amongst a predefined plurality of stored images, the first similarity being calculated from the second information items associated respectively with the example image and the stored image under consideration;

providing a first subset of images selected from amongst the predefined plurality of images according to their degree of first similarity with the example image;

calculating a second similarity between the example image and each of the images amongst the first subset of selected images, the second similarity being calculated from the first information items associated respectively with the example image and the selected image under consideration;

providing at least one image referred to as a result image, the at least one result image being selected from amongst the first subset of selected images, according to its degree of second similarity with the example image.

12. (Amended) An image search method according to Claim 11, wherein said step of calculating a first similarity between the example image and each of the images amongst a predefined plurality of stored images is implemented by calculating a distance between the second information item associated with the example image and the second information item associated with the stored image under consideration.

13. (Amended) An image search method according to Claim 11, wherein said step of calculating a first similarity

between the example image and each of the images amongst a predefined plurality of stored images is implemented by an isomorphism detection method applied to the quadtrees representing the second information items associated respectively with the example image and the stored image under consideration.

14. (Amended) An image search method according to any one of Claims 11 to 13, wherein said step of calculating a second similarity between the example image and each of the images amongst the first subset of selected images is implemented by calculating a distance between the first information item associated with the example image and the first information item associated with the stored image under consideration.

15. (Amended) An image search method according to Claim 14, wherein said step of calculating the second similarity is implemented by calculating the sum of the distances between each of the components of the first information item associated with the example image and the corresponding component of the first information item associated with the stored image under consideration.

16.   (Amended) An image search method according to Claim 15, wherein each of the components of the first information items associated with the example image and with the stored image under consideration is a colour histogram and the sum of the distances between these components is the sum of the intersections between these components.

17.   (Amended) A digital data processing device, comprising means adapted to implement an image indexing method according to any one of Claims 1 to 4, 7 and 8.

18.   (Amended) A digital data processing device, comprising means adapted to implement an image search method according to any one of Claims 10 to 13.

19.   (Canceled) Digital data processing device, characterised in that it comprises means adapted to implement an image indexing method according to any one of Claims 1 to 9, and means adapted to implement an image search method according to any one of Claims 10 to 16.

20.   (Amended) A computer, comprising a digital data processing device according to Claim 17.

21.   (Amended) A computer program comprising program instructions for causing a computer to perform an image indexing method according to any one of Claims 1 to 4, 7 and 8.

22.   (Amended) A computer readable medium having thereon a computer program comprising computer executable instructions for causing a computer to perform an image indexing method according to any one of Claims 1 to 4, 7 and 8.

23.   (Amended) A computer program comprising program instructions for causing a computer to perform an image search method according to any one of Claims 10 to 13.

24.   (Amended) A computer readable medium having thereon a computer program comprising computer executable instructions for causing a computer to perform an image search method according to any one of Claims 10 to 13.

Please add Claims 25-31 as follows:

--25.   A digital image indexing method according to Claim 12, wherein said step of generating the second information item comprises the following substeps:

calculating, for each of the blocks, a data item of a second type indicative of a degree of significance of the visual content of the block under consideration with respect to the overall content of the image;

generating the second information item as being a vector having N components, each of which is one of the data items of the second type.

26.   An image indexing method according to Claim 25, wherein, for each of the blocks, the data item of a second type, indicative of a degree of significance of the visual content of the block under consideration with respect to the overall content of the image, is obtained by applying the following formula:

$$w_i^{\mathrm{Im}} = \frac{\left\| h_i^{\mathrm{Im}} \right\|}{\sum\limits_{i=1}^{N} \left\| h_i^{\mathrm{Im}} \right\|}$$

according to which the data item of the second type is obtained by calculating the ratio between the

Euclidean norm of the data item of the first type associated

with the block under consideration and the sum of the

Euclidean norms of the data items of the first type

associated with all the blocks of the image.

27. An image indexing method according to Claim

12, wherein the image plane of the image is divided according

to a rectangular grid.

28. An image indexing method according to

Claim 27, wherein the predefined number N of blocks is equal

to sixteen.

29. A digital image indexing method according to

Claim 13, wherein:

the image plane of the image is divided

according to a quadtree decomposition process by means of

which, at each phase of the decomposition, a block under

consideration, referred to as the "parent block", is

decomposed into four blocks, referred to as "child blocks",

equal in size to a quarter the size of the parent block, and

whose combination gives the parent block, the decomposition

beginning with the overall image plane of the image and finishing when the predefined number N of blocks is reached;

at each phase of the decomposition, there is calculated, for each of the child blocks, a data item of a second type, indicative of a degree of significance of the visual content of the child block under consideration with respect to the overall visual content of the parent block; and

the second information item is composed of the set of the data items of the second type stored according to a quadtree structure, each node of which is constituted by one of the data items of the second type.

30. An image indexing method according to Claim 29, wherein:

at each phase of the quadtree decomposition of the image, there is extracted, from the parent block under consideration, a data item of the first type representing at least one characteristic of its visual content and, for each child block obtained by decomposition of the parent block , there is extracted a data item of the first type representing at least one characteristic of the visual content of the child block under consideration;

the data item of the second type indicative of

a degree of significance of the visual content of a child

block under consideration with respect to the overall visual

content of the corresponding parent block is obtained by

applying the following formula:

$$w_i^p = \frac{\left\| h_f^p \right\|}{\left\| h_p \right\|}$$

according to which the data item of the second type

calculated for a child block under consideration is obtained

by calculating the ratio between the Euclidean norm of the

data item of the first type extracted for the said child

block under consideration and the Euclidean norm of the data

item of the first type extracted from the corresponding

parent block.

31. A computer, comprising a digital data

processing device according to Claim 18.--

<u>REMARKS</u>

Claims 1-18 and 20-24 have been amended to

eliminate improper multiple dependencies and to correct a

number of typographical errors. Claim 19 has been canceled

without prejudice or disclaimer of subject matter, and Claims

25-31 have been added to assure Applicant of a full measure

of protection. These changes do not affect the scope of any

of the amended claims.

Applicant's undersigned attorney may be reached in

our New York office by telephone at (212) 218-2100. All

correspondence should continue to be directed to our below

listed address.

Respectfully submitted,

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VERSION MARKED TO SHOW CLAIM CHANGES

1.   (Amended) [Method] A method of indexing a
digital image, [characterised in that it comprises]
comprising the following steps:

generating [(S31)] a first information item
(H(Im)) characteristic of the visual content of the said
image (Im);

generating [(S32)] a second information item
[(W(Im))] characteristic of the spatial distribution of the
visual content of the image [(Im)] in its image plane;

associating [(S33)], with the [said] image
[(Im)], an index [(IDX(Im))] composed of the [said] first
information item [(H(Im))] and the [said] second information
item [(W(Im))].

2.   (Amended) [Digital] A digital image indexing
method according to Claim 1, [characterised in that the]
wherein said step of generating the [said] first information
item [(H(Im))] comprises the following substeps:

dividing [(S310)] the image plane of the
[said] image [(Im)] according to a partitioning comprising a
predefined number N of blocks [(B$_i$)];

extracting [(S312)], from each of the [said]
blocks [(B$_i$)], a data item of a first type [(h_i^{Im})]
representing at least one characteristic of the visual
content of the block under consideration;

generating [(S315)] the [said] first
information item [(H(Im))] as being a vector having N
components, each of which is one of the [said] data items of
the first type [(h_i^{Im})].

3.   (Amended) [Digital] <u>A digital</u> image indexing
method according to Claim 2, [characterised in that the]
<u>wherein said</u> step of generating the [said] second information
item [(W(Im))] comprises the following substeps:

calculating, for each of the [said] blocks
[(B$_i$)], a data item of a second type [(w_i^{Im})] indicative of a
degree of significance of the visual content of the block
[(B$_i$)] under consideration with respect to the overall
content of the [said] image [(Im)];

generating [(S32)] the [said] second information item [(W(Im)] as being a vector having N components, each of which is one of the [said] data items of the second type [(w_i^{Im})].

4.   (Amended) [Image] <u>An image</u> indexing method according to Claim 3, [characterised in that] <u>wherein,</u> for each of the [said] blocks [(B_i)], the [said] data item of a second type [(w_i^{Im})], indicative of a degree of significance of the visual content of the block [(B_i)] under consideration with respect to the overall content of the [said] image [(Im)], is obtained by applying the following formula:

$$ w_i^{\text{Im}} = \frac{\left\| h_i^{\text{Im}} \right\|}{\sum\limits_{i=1}^{N} \left\| h_i^{\text{Im}} \right\|} $$

according to which the [said] data item of the second type (w_i^{Im}) is obtained by calculating the ratio between the Euclidean norm of the data item [(h_i^{Im})] of the first type associated with the block [(B_i)] under consideration and the sum of the Euclidean norms of the data

items of the first type associated with all the blocks of the image [(Im)].

5. (Amended) [Image] An image indexing method according to any one of Claims 2 to 4, [characterised in that] wherein the image plane of the [said] image [(Im)] is divided according to a rectangular grid.

6. (Amended) [Image] An image indexing method according to Claim 5, [characterised in that] wherein the [said] predefined number N of blocks is equal to sixteen.

7. (Amended) [Digital] A digital image indexing method according to Claim 2, [characterised in that] wherein:

the image plane of the [said] image [(Im)] is divided according to a quadtree decomposition process by means of which, at each phase of the decomposition, a block under consideration, referred to as the "parent block" [(B_p)], is decomposed into four blocks, referred to as "child blocks" [(B_f^p)], equal in size to a quarter the size of the parent block, and whose combination gives the parent block, the [said] decomposition beginning with the overall

image plane of the [said] image [(Im)] and finishing when the predefined number N of blocks is reached;

at each phase of the decomposition, there is calculated, for each of the [said] child blocks [(B_f^p)], a data item [(w_f^p)] of a second type, indicative of a degree of significance of the visual content of the child block under consideration with respect to the overall visual content of the parent block [(B_p)]; and

the [said] second information item [(W(Im))] is composed of the set of the [said] data items [(w_f^p)] of the second type stored according to a quadtree structure, each node of which is constituted by one of the [said] data items of the second type.

8.   (Amended) [Image] <u>An image</u> indexing method according to Claim 7, [characterised in that] <u>wherein</u>:

at each phase of the quadtree decomposition of the [said] image [(Im)], there is extracted, from the parent block [(B_p)] under consideration, a data item [(h_p)] of the first type representing at least one characteristic of its visual content and, for each child block [(B_f^p)] obtained by decomposition of the [said] parent block [(B_p)], there is

extracted a data item [(h_f^p)] of the first type representing

at least one characteristic of the visual content of the

child block under consideration;

the [said] data item [(w_f^p)] of the second

type indicative of a degree of significance of the visual

content of a child block [(B_f^p)] under consideration with

respect to the overall visual content of the corresponding

parent block [(B_p)] is obtained by applying the following

formula:

$$w_i^p = \frac{\left\| h_f^p \right\|}{\left\| h_p \right\|}$$

according to which the [said] data item of the second type

[(w_f^p)] calculated for a child block under consideration

[(B_f^p)] is obtained by calculating the ratio between the

Euclidean norm of the data item [(h_f^p)] of the first type

extracted for the said child block [(B_f^p)] under

consideration and the Euclidean norm of the data item [(h_p)]

of the first type extracted from the corresponding parent

block [(B_p)].

9.   (Amended) [Image] <u>An image</u> indexing method according to any one of Claims 2 to [8] <u>4</u>, [characterised in that] <u>wherein</u> each of the [said] data items of the first type, representing at least one characteristic of the visual content of a block under consideration of the [said] image, represents the distribution of colours in the [said] block.

10.   (Amended) [Method] <u>A method</u> of searching for images, from an example image, in a database in which digital images are stored, [characterised in that] <u>wherein</u> the [said] example image and each of the images stored in the database are indexed according to an image indexing method in accordance with [any one of the previous claims] <u>Claim 1</u>.

11.   (Amended) <u>An image</u> [Image] search method according to Claim 10, [characterised in that it comprises] <u>comprising</u> the following steps:

calculating [(S609)] a first similarity [(Filter)] between the [said] example image [(Q)] and each of the images [(D)] amongst a predefined plurality of stored images, the [said] first similarity being calculated from the [said] second information items [(W(Q) ; W(D))] associated

respectively with the [said] example image [(Q)] and the

stored image [(D)] under consideration;

providing [(S617)] a first subset of images

selected [(S615)] from amongst the [said] predefined

plurality of images according to their degree of first

similarity [(Filter)] with the [said] example image [(Q)];

calculating [(S623)] a second similarity

[(Match)] between the [said] example image [(Q)] and each of

the images [(Ds)] amongst the [said] first subset of selected

images, the [said] second similarity being calculated from

the [said] first information items [(H(Q) ; H(Ds)] associated

respectively with the [said] example image [(Q)] and the

selected image [(Ds)] under consideration;

providing [(S631)] at least one image referred

to as a result image, the [said] at least one result image

being selected [(S629)] from amongst the [said] first subset

of selected images, according to its degree of second

similarity [(Match)] with the [said] example image.

12.   (Amended) [Image] An image search method

according to Claim 11[when it is combined with any one of

Claims 3 to 6], [characterised in that the] wherein said step

[(S609)] of calculating a first similarity [(Filter)] between the [said] example image [(Q)] and each of the images [(D)] amongst a predefined plurality of stored images is implemented by calculating a distance between the second information item [(W(Q))] associated with the [said] example image and the second information item [(W(D))] associated with the [said] stored image under consideration [(D)].

13.   (Amended) [Image] An image search method according to Claim 11[when it is combined with Claim 7 or 8], [characterised in that the] wherein said step [(S609)] of calculating a first similarity [(Filter)] between the [said] example image [(Q)] and each of the images [(D)] amongst a predefined plurality of stored images is implemented by an isomorphism detection method applied to the quadtrees representing the [said] second information items [(W(Q) ; W(D))] associated respectively with the [said] example image [(Q)] and the stored image [(D)] under consideration.

14.   (Amended) [Image] An image search method according to any one of Claims 11 to 13, [characterised in that the] wherein said step of calculating a second

similarity [(Match)] between the [said] example image [(Q)]

and each of the images [(Ds)] amongst the [said] first subset

of selected images is implemented by calculating a distance

between the first information item [(H(Q))] associated with

the [said] example image and the first information item

[(H(D))] associated with the [said] stored image under

consideration [(D)].

15.   (Amended) [Image] An image search method

according to Claim 14, [characterised in that the] wherein

said step of calculating the [said] second similarity

[(Match)] is implemented by calculating the sum of the

distances between each of the components [(h_i^Q)] of the first

information item [(H(Q))] associated with the example image

[(Q)] and the corresponding component [(h_i^{Ds})] of the first

information item [(H(Ds))] associated with the stored image

[(Ds)] under consideration.

16.   (Amended) [Image] An image search method

according to Claim 15, [characterised in that] wherein each

of the components [(h_i^Q, h_i^{Ds})] of the [said] first information

items [(H(Q), H(D))] associated with the example image [(Q)]

and with the stored image [(Ds)] under consideration is a colour histogram and the [said] sum of the distances between these components is the sum of the intersections between these components.

17.   (Amended) [Digital] A digital data processing device, [characterised in that it comprises] comprising means adapted to implement an image indexing method according to any one of Claims 1 to 4, 7 and 8 [9].

18.   (Amended) [Digital] A digital data processing device, [characterised in that it comprises] comprising means adapted to implement an image search method according to any one of Claims 10 to 13 [16].

19.   (Canceled)

20.   (Amended) [Computer, characterised in that it comprises] A computer, comprising a digital data processing device according to Claim 17[or 18].

21. (Amended) A computer program comprising program instructions for causing a computer to perform an image indexing method according to any one of Claims 1 to 4, 7 and 8 [9].

22. (Amended) A computer readable medium having thereon a computer program comprising computer executable instructions for causing a computer to perform an image indexing method according to any one of Claims 1 to 4, 7 and 8 [9].

23. (Amended) A computer program comprising program instructions for causing a computer to perform an image search method according to any one of Claims 10 to 13 [16].

24. (Amended) A computer readable medium having thereon a computer program comprising computer executable instructions for causing a computer to perform an image search method according to any one of Claims 10 to 13 [16].